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§ 126. **The Eccentricity of the Pith of Rhus toxicodendron.**—This subject was briefly discussed at the April meeting of the Club, by Mr. J. B. Hyatt, who seems to have been the first to notice the fact. (BULLETIN, Vol. VI., p. 47.) An article on the subject, written by Lester F. Ward, had appeared in *The American Naturalist*, for that month.

Mr. Hyatt attributes this eccentricity to the heat which the Rhus receives from its support on the inner, or supported side.

Mr. Ward leaves the question somewhat open, though he intimates quite strongly his conviction, that it is due to absorbtion of nourishment by the aerial rootlets; that these rootlets are parasitic, and that they deposit the nourishment, which they collect near the point of their emission from the stem. At least, after detailing his numerous examinations of different specimens of the plant under widely varying circumstances, he says, "these facts all unite in pointing to a physical connection of some kind between the penetration of the rootlets and the eccentricity of the pith. The notion thus far entertained, and which has found its way into our standard text-books, that these rootlets are not for absorbing nourishment, but for climbing, may, in future, require some modification." Anticipating the objection that these rootlets are neither parasitic, nor merely for climbing, but true roots, finding "congenial soil in the corky layer of bark, in the soft mass of decomposed wood, and even to some extent in the minute cryptogamic vegetation that always exists among them, even when clinging to walls of brick or stone," he is at a loss how to account for "the strange eccentricity of the annual rings."

Neither of the foregoing explanations is satisfactory to my mind. That of Mr. Hyatt is exceedingly unsatisfactory, because, if true, all climbing plants closely fixed to supports larger than themselves, should show the same eccentricity to a greater or less extent, directly in proportion to the heat absorbing power of such support. Facts, however, are not in harmony with any such conclusion. I have examined a number of climbing plants with reference to this point with a negative result in every case.

Eccentricity of pith I found in Rhus toxicodendron, Ampelopsis quinquefolia, and, in the only specimen examined, Hedera Helix (English Ivy), but in neither of these have I been able to trace any apparent connection between the degree of eccentricity, and the amount of heat which the plant received from its support. In Ampelopsis quinquefolia the eccentricity seems quite variable, being sometimes on the inner, sometimes on the outer side. In the greater number of instances, however, the thickest growth was on the unsupported side, or exactly the reverse of the condition found in Rhus toxicodendron. In the single case of Hedera Helix examined, the thickest growth was on the supported side. The plant was growing up the north face of a ledge of rocks, where the rays of the sun could never reach it. This, it will be remembered, is a root climber.

In Celastrus scandens, a woody twiner, the pith is always centric, unless, by the growth of the supporting tree, pressure is made upon the inner side, when it becomes flattened. In other words, when the pith is eccentric, it is so from a mere mechanical impediment to the natural growth, which affects it in the same manner, and to the same extent, as it would any other plant, not a climber. Mr. Ward's examinations incidentally furnish the same results. For instance, he says he always found the eccentricity less in specimens growing upon stones than in those upon trees. Now, when we consider the amount of heat absorbed by stones in the day-time, during the growing season of plants, and that this is radiated during the night, it becomes evident that a plant growing in such a position, will be in a more equable temperature, and a higher one, than one climbing a tree trunk. It should, then, if Mr. Hyatt's theory be true, show greater eccentricity of pith, whereas it shows less.

One of the best marked specimens of eccentricity which I have was found on the north-west side of a tree trunk, near its base, where the sun could never reach it.

The growth of plant stems generally does not depend upon the heat which they directly receive. The conditions necessary are sufficient nourishment at the roots and sufficient light and heat for the leaves to elaborate this food ; these conditions being present, the storing up of the products of vegetable digestion will go on in the stem. Gray says, "The greater the development of vigorous branches on a particular side of a tree, the more wood is formed, and the greater the thickness of the annual layers on that side of the trunk." *

These arguments seem to me sufficient to warrant the rejection of Mr. Hyatt's theory.

Whether the rootlets are, or are not, parasitic, as Mr. Ward inclines to believe them, may now be considered. We have as negative evidence against their parasitic nature, no recorded instance of their ever having been traced to the cambriun of a living support. On the other hand, in addition to the reasons which Mr. Ward gives for their being collectors of nourishment, either as parasitic or true roots, there is the fact that when climbing a support, the plant attains a much greater size than when unsupported. This, at first sight, appears to be a good reason for thinking that the plant may receive other nourishment than that furnished by its roots that penetrate the earth. This, however, I hope to show, is only apparent, not real. But first let us grant, for the sake of argument, that these rootlets do collect nourishment. Then they cannot accomplish this in a parasitic way, because the plant will grow as high, as large, and spread as extensively upon a dead tree as upon a living one. This could not occur if the plant were, in any degree, parasitic. So, then, if the rootlets do collect nourishment they must do so in the character of true roots. Let us see where such an hypothesis would lead. It would inevitably bring us to the conclusion that Rhus toxicodendron puts forth true roots in the great-

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* Structural and Systematic Botany. Note on page 130.

est possible profusion in those situations where there is the least possible nourishment. In other words, it would require us to believe that this plant has the laws that generally govern root-growth reversed in its favor. Now I have repeatedly observed that this plant, lying prostrate upon the ground, roots in just about the same manner, and to the same extent, as any other ordinary plant would root under the same circumstances. Stems growing in such situations, have their pith centric. A large number of plant stems will strike true roots freely in the presence of moisture, and, when surrounded by proper nourishment, these roots will increase extensively. Rhus toxicodendron being no exceptive to this rule, can it be believed that it will, in the absence of these conditions, root a hundred times more freely? I have no hesitation in rejecting a theory which demands such credulity.

If, then, these rootlets do not collect nourishment in any manner—and, if my reasoning be correct, they do not—any theory to account for the eccentricity of pith, founded upon such office, necessarily falls to the ground. How, then, shall we account for it? I think we shall arrive at a solution of that question when we have solved one which should have preceded it, and that is in response to what stimulus do these innumerable rootlets issue?

Dr. Bigelow in his "Medical Botany," published in 1820, says he has "observed that young plants of Rhus radicans frequently do not put out rooting fibres until they are several years old, and that they seem, in this respect, to be considerably influenced by contiguity of supporting objects." Mr. Ward mentioned a "vine upwards of an inch in diameter at the base" which "had climbed a cedar tree to the top, and, no longer finding anything to adhere to, sent out free fruiting branches nearly half an inch thick." Later on he says, "On the projecting branches of the same vine, bearing the berries and *showing no tendency to cling*, *there was no appreciable eccentricity*." Here we have at the top of a tree which the plant had climbed, free branches half an inch thick without rootlets. This goes to confirm Dr. Bigelow's remark concerning the influence of contiguity of supporting objects. I have made numerous observations upon this point, and all tending to establish the principle that contiguity of supporting objects is the main factor in the causation of the emission of rootlets. One instance only will I mention particularly. A vine about an inch in diameter had climbed the perpendicular face of a large rock, on its north side, adhering very closely. At the top it branched extensively, some of the branches being nearly half an inch in diameter, and, ascending from the rock, looked very much like a bush growing there. All of these ascending branches, even to the largest, were very nearly free from rootlets. In cases where the stem had at any previous time adhered, and the union had been broken, I noted both a tendency toward recovery from eccentricity of pith, and a marked diminution in the production of rootlets as compared with those adhering portions of the stem both above and below. These facts, to my mind, demonstrate conclusively that Rhus toxicodendron is stimulated to put forth rootlets for climbing, by contact with a supporting object, in just the same manner as it, in common with many other plants, is stimulated by contact with moist earth to put out true roots. That very many plants possess an irritability which responds to the stimulation of contact is a well-known fact. Those which respond by movements perceptible to the eye may be passed with a mere mention, while we consider some of those more directly bearing upon the question which we are discussing. Tendril bearers show this irritability in a marked degree, as also do the petioles of leaf climbers. So necessary is this stimulation to the tendrils of Ampelopsis quinquefolia that they wither and die without it; upon grasping an object, however, they increase in strength, become woody, and retain their hold for years.

Darwin, in his work on "Climbing Plants," details a great number of curious and interesting experiments which amply demonstrate this irritability and its effects. In speaking of the genus Clematis, he says, "When a petiole has clasped a twig it undergoes some remarkable changes. * * * The clasped petiole in the course of two or three days swells greatly, and ultimately becomes nearly twice as thick as the opposite one which has clasped nothing. When thin transverse slices of the two are placed under the microscope their difference is conspicuous ; the side of the petiole which has been in contact with the support is formed of colorless cells with their longer axis directed from the centre, and these are very much larger than corresponding cells in the opposite or unchanged petiole." The sensitiveness of the petioles in this genus, however was limited to the younger leaves. Solanum jasminoides gave more decided results. Here he found the petiole of the full grown leaf still sensitive, and, when it had clasped a support, the subsequent changes were still greater. After detailing his examination of this plant, he says, "It is a singular morphological fact that the petiole should thus acquire a structure almost identically the same with that of the axis ; and it is a still more singular physiological fact that so great a change should have been induced by the mere act of clasping a support." Many other examples might be presented, but it is unnecessary. The irritability which I claim for the stem of Rhus toxicodendron differs only in degree from the instances just related. This difference might justly be expected when the ends to be attained are considered. In the one case, a short lived leaf petiole is made the sensitive organ, and serves its purpose for the time required; in the other, the whole stem is made sensitive in order to support itself for years. It may be urged against this theory that unsupported stems do put forth occasional rootlets. This objection should not be considered valid. The nature of the plant is of course strongly bent toward the production of rootlets, and with this evidently strong predisposition, it need not be considered strange if some are produced without the stimulation which is usually requisite. Some plants put forth adventitious roots from the lower portions of their stems which tend downward and enter the earth, but no one would, on this account, claim that as the normal type of root growth. The rootlets being put forth in response to the stimulation of contact, I consider that eccentricity of pith follows incidentally, and in the following manner; in the absence of special organs, as nerves, to conduct the stimulus of an irritant, in vegetables irritation can only be conveyed from cell to cell, and hence the further a cell is located from the origin of the irritation the less its effect will be felt. Now irritation within natural limits can only serve to increase cell activity and growth. This is just what Darwin found in the cases which I have quoted; and it is just what I should expect to find in the plant under consideration.

In the same manner it would seem reasonable to account for the great difference in size existing between the supported and the unsupported plant. This difference has long been noted, and doubtless Linnæus and others following him founded their different species *mainly* upon that character. In the one instance the plant has, so to speak, every energy brought into full activity, while in the other, one great incitement to full activity is witheld. The former attains its full stature, the latter remains a dwarf.

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§ 127. **Fresh Water Algae.**—Collected during the past three years, mostly within a circuit of about twenty miles around Bethlehem, Penn., by Francis Wolle.

[Thirty species believed to be new to the United States and ten entirely new discoveries are indicated by Italics.]

DESMIDIEÆ.

1. **Palmoglœa,** Ktz.—*P. clamydospera,* de By.
2. **Penium,** Breb.—P. digitis, Breb.—P. Closteroides, Ralfs.—P. interruptum, Breb.—P. *oblongum,* de By.
3. **Closterium,** Nitzsch.—*C. obtusum,* Breb.—C. angustatum, Ktz.—C. striolatum, Ehrb.—C. lunula, Ehrb.—C. Ehrenbergii, Menegh.—C. Leibleinii, Ktz.—C. Dianae, Ehrb.—C. Venus, Ktz.—C. parvulum, Naeg.—C. Jenneri, Ralfs.—C. rostratum, Ehrb.—C. setaceum, Ehrb.—C. moniliferum, Bory.—C. lineatum, Ehrb.—C. acerosum, Ehrb.—C. *turgidum,* Ehrb.
4. **Tetmemorus,** Ralfs.—T. Brebissonii, Menegh.—T. lævis, Ktz.
5. **Pleurotaenium,** Naeg.—P. Trabecula, Naeg.—P. clavatum, Ktz.—P. crenulatum, Ehrb.—P. hirsutum, Bailey.—P. nodosum, Bailey.
6. **Spirotaenia,** Breb.—S. condensata, Breb.
7. **Sphaerozosma,** Corda.—S. excavatum, Ralfs.
8. **Hyalotheca,** Ehrb.—H. dissiliens, Breb.—H. mucosa, Ehrb.
9. **Bambusina,** Ktz.—B. Brebissonii, Ktz.
10. **Didymoprium,** Ktz.—D. Grevillii, Ktz.
11. **Desmidium,** Ag.—D. Swartzii, Ag.—D. Swartzii, *var.* Ralfsii.—D. aptogonum, Breb.
12. **Aptogonum,** Ralfs.—A. Baileyi, Ralfs, finely in fruit.
13. **Cosmarium,** Corda.—C. margaritiferum, Menegh.—C. Botrytis, Menegh.—C. ovale, Ralfs.—C. tetrophthalmum, Ktz.—C. *conspersum,* Ralfs.—*C. Portianum,* Archer.—*C. Ralfsii,* Breb.—*C. læve,* Rab.—C. Cucumis, Corda.—C. pyramidatum, Breb.—